



## MARKET LIBERALIZATION AND TRADING IN KOREA

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### Abstract

This paper reports on the trading behavior of major participants, investment trust companies, banks, and foreigners in South Korea in the period after the currency markets were liberalized and the limits on foreign investments were lifted. It was found that trading in the spot currency market was impacted by volatility in the daily Won/USD rates. As the daily unexpected range expanded (narrowed), daily spot trading volume and volatility increased (decreased). This is evidence of asymmetric trading behavior on the part of market participants. It was found that only investment trust companies adjusted their spot positions by trading USD futures as a response to unexpected volatility changes of the exchange rate. There is evidence of volatility clustering of the trading volatilities across Korean markets and trader types and no signs of market instability was found.

Keywords: South Korea, Market liberalization, Trading behavior, Currency, Multivariate GARCH model

JEL classification: F21, F31, G14

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### 1. Introduction

The financial markets in South Korea have grown rapidly over the past decade. Research on Korea's economy and its financial markets has grown even faster. Korea has recently become one of the most active financial markets as well. It is categorized as an emerging market. Its derivative trading, in terms of trading volume and value is among the highest in the world. Despite the growth, very little attention has been given to its currency derivatives market (Kim, Kim and Kim (2004) and an examination of all of its markets in an integrative fashion.

A liberalization of the exchange rate system and the capital market of a country impacts the various financial markets in many different ways. Market liberalization is typically seen as a prelude to financial integration so that the full

benefits of globalization can be obtained once all capital controls are removed. These benefits are presumed to include more stable exchange rates and higher growth rates in the economy, not to mention the lowering of risk. At least this has been the conventional thinking up until recently. Bekaert, Harvey, Lunblad and Siegal (2007) propose that capital market openness holds the greatest potential for growth opportunities in liberalizing countries.

However, there is an emerging viewpoint that holds that such market liberalizations might in fact lead to financial instability and impair the ability of the government to deal with negative macroeconomic shocks. For a detailed view of this strand of thinking, one can look at papers by Stiglitz (2000, 2004) and others. Other papers associate such liberalizations with reduced cost of equity capital, increased returns to equity positions and net capital inflows: see papers by Henry (2000), Bekaert and Harvey (2000) and Kim, Landi and Yoo (2009). In essence there is controversy over the perceived benefits and costs of market liberalization.

In February 1980, Korea replaced its fixed exchange rate system with a multiple-basket pegged exchange rate system, thus permitting the exchange rate to fluctuate against major currencies relevant for its trade. Under this system, the basic exchange rate of the Won against the USD was determined as the weighted average of two baskets.<sup>1</sup> In March 1990 the multiple-basket pegged exchange rate system was itself replaced by the Market Average Exchange Rate System (MARS). In December 1997 (during the peak of the Asian financial crisis period) the daily fluctuation limits for the interbank exchange rate were abolished and thus South Korea's exchange rate system shifted to a totally free-floating mechanism at that time.<sup>2</sup> In May 1998, the country's stock and money markets were also opened to foreign investor ownership.

The impact of exchange rate fluctuation on the stock markets can be summarized by at least two major facts. First, the volatility of the exchange rate influences firms' import and export businesses and other businesses sensitive to foreign exchange rates. This in turn affects their stock prices. Second, investors in foreign stock markets are subject to foreign exchange risk. Therefore, in order to avoid facing these risks, they may hold currency market positions or trade financial derivatives so as to hedge the increased currency risks. Such derivative trading may have spillover effects on the stock market. They may also demand higher interest rates to compensate for the increased volatility, if traders choose not to hedge, and are invested in the spot debt markets.

<sup>1</sup>The two baskets are the SDR basket and a trade-weighted basket composed of major trading currencies, with an adjustment factor which was termed the policy variable:  $Exchange\ Rate = \alpha \cdot SDR\ basket + \beta \cdot TWB + P$  [ $\alpha + \beta = 1$ ].

<sup>2</sup>The exchange rate bands are  $\pm 2.25\%$  and free before December 1, 1997, between December 1, 1997 and November 20, 1997, and after December 16, 1997, respectively.

Some papers have examined whether foreigners are at a disadvantage in

the Korean market (Choe, Kho and Stulz (RFS), 2005) either because of lack of information available to foreigners or because foreigners face higher trading costs. By examining the cost structure of trades made by foreigners versus domestic traders, they concluded that foreigners face higher costs on their medium and large sized trades in the stock market.<sup>3</sup> Kim and Yoo (2009) investigated the different behavior of equity investors in the Korean markets. They concluded that foreign investors are not speculators but long-term value investors. Kim, Land and Yoo (2009) also examined the inter-temporal behavior of foreign investors in the Korean equity markets. They showed that increases (decreases) in the net inflows of foreign funds lead to the appreciation (depreciation) of value of the Won. However, the reverse causation link does not hold.

The motivation of this study was to explore the trading behavior of investment trust companies (ITCs), banks, and foreigners, under the free-floating exchange rate system and open capital and financial markets to assess evidence of adverse consequences of liberalization, if any. These groups are the dominant entities in the Korean markets and any material change in the markets will be reflected through their trading activities. Hence this will be a good place to search for any evidence of instability in the markets.

Our paper contributes to the current literature on market liberalization by studying its impact on the spot currency, stock and futures markets in a particular country that has just undergone market liberalization. Korea is a good test case as there is reasonable legal protection for foreign investors in her markets.<sup>4</sup> The study specifically tried to find out whether the patterns of trade in these markets changed drastically, which might give clues of some instability in the markets. The primary mechanism for the investigation is the linkages between the volatility of the daily high and low exchange rates (Won/USD) and the trading behavior of the different categories of the major market participants.<sup>5</sup>

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<sup>3</sup> Their data set ends at the year both the capital and foreign exchange markets were liberated. Ours starts at the beginning of this period and is therefore a post-liberalization analysis of the markets.

<sup>4</sup> There is a substantive literature that points the existence of a substantial "home bias" for investors. Hence if the opening of a foreign market will lead to substantial capital inflows, there must not only be the promise of substantial returns but also enough protection in place to preserve their control rights over their assets.

<sup>5</sup> Individual investors do not have a major role in the currency, derivatives or stock markets in Korea. Their share of the trading volume and market capitalization is very small and (Choe, Kho and Stulz (RFS 2005), reported that only 4.1% of individuals held stock market positions. Since there is no detailed firm level data, the track positions of firms over time. Hence the duration of individual positions cannot be tracked in the different markets was not examined.

First, the study examined whether the major players have different trading

behavior due to expected and unexpected volatilities in the exchange rate, namely to find out whether these players exhibit asymmetric trading behaviors.<sup>6</sup> Second, we analyze the relations between the major players' trading behavior and the volatility of USD futures volume. This information was used to determine whether these players go long or short by trading USD futures simultaneously for hedging or speculation purposes.

This article is organized as follows. Section 2 provides previous related research findings on exchange rates and stock returns. Section 3 discusses the characteristics of the research model. Empirical results are presented in Section 4. The paper ends with a brief conclusion in Section 5.

## **2. Literature Review**

Most previous papers focused on the impact of exchange rate volatility on stock price and returns. For example, Chen and Shen (2004), investigated the inter-linkages between Taiwan's stock and exchange rate markets. Their results showed that unrestricted trading volumes reveal more information regarding the market than otherwise because of the distortionary effects of government's foreign exchange market interventions on the volatility prices in the markets. Nevertheless they find that a common volatility factor drives stock and exchange markets dynamics.

Ramasamy and Yeung (2005) employ Granger causality methodology to consider causality between exchange rates and stock market returns in nine East Asian economies. They find that the direction of causality can vary according to the period of study. When the entire four years of the Asian crisis (1997-2000) were analyzed, they found that, apart from Hong Kong, all other countries indicate evidence that stock prices Granger cause movements in the exchange rate and imply that capital outflows trigger the exchange rate declines.

Aquino (2005) examined whether changes in stock market prices in the Philippines were triggered by FX risk during the period 1992-2001, specifically before and after the onset of the Asian financial crisis. Their evidence suggested that stock returns did not react significantly to foreign exchange rate fluctuations before the crisis. After the onset of the crisis, however, prices of Filipino firms started to exhibit cross-sectional differences in their reaction to exchange rate movements.

During the post-crisis period, market participants began to expect a risk premium on their investments for their perceived added exposure to exchange rate risk. As stock returns did not adequately compensate for the FX risk, risk-averse investors increased their demand for hedging the unpriced FX risk. In the

<sup>6</sup> There is already evidence of asymmetric response in stock markets to good and bad news. Not only do we want to find evidence of such behaviors in the Korean markets but we want to find out whether all classes of participants operate similarly. Ours priors, are, that they would tend to act similarly.

larger macroeconomic sense, this implies that market inefficiencies occur either

in the foreign exchange market or stock market or in both. Moreover, local firms did not hedge adequately for foreign exchange risk. Similar research studies are abundant: see for example, Valckx (2004), Bailey, Mao and Chang (2003), Doukas, Lang and Hall (1999), Malliaropulos (1998), Bailey and Chung (1995), and Solnik (1984).

A few tried to analyze the relationship between the volatility of a foreign exchange market and players' behavior, especially in the South Korea market. Some studies examined the relation between exchange rate volatility and the trading volume of currency derivatives contracts. In this vein, Chatrath, Ramchander and Fong (1996) examined the relationship between the level of trading in currency futures and the variability in the underlying exchange rates.

Their results indicate a positive relationship between the level of futures trading activity and the volatility in exchange rate changes. They show that future activity has a positive impact on the conditional volatility in the exchange rate changes, with a weaker feedback from exchange rate volatility to future activity. Furthermore, the positive impact of shocks in future trading activity on exchange rate volatility is found to persist over several trading days.

Another group of studies focused on the impact of volatility of the foreign exchange rate on the trading behaviors of financial market participants. Wang (2002) investigated the effect of net positions by type of trader on return volatility in the six major foreign currency future markets. The principal findings were: (i) volatility is positively associated with unexpected changes (in either direction) in the net positions of speculators and small traders; (ii) volatility is negatively associated with unexpected changes (in either direction) in the net positions of hedgers.

Chiu, Chen, and Tang (2005) also studied the effects of South Korea's shift to a free-floating exchange rate system covering the period November 11, 1997 to June 30, 2004. They found that such an event did not impact foreign players' trading behavior, or that the move in currency market was negligible, in their view. Covrig and Melvin (2005) offered that yen/dollar exchange rate quotes adjust to full-information levels three times faster when the informed traders are active versus when they are not. These results are consistent with a view of the foreign exchange market where private information is at times quite important. From the above studies, it was noted that traders' behavior are apparently unaffected by public or expected information. Thus, the linkage between the unexpected components and future trading was tested.

### **3. Data and Econometric Model**

#### **3.1. Data**

The Korea Futures Exchange (KOFEX), launched on April 23, 1999, has become the largest derivative exchange in the world in 2004, by total annual volume of contracts traded. It registered trading of 2,586,818,602 contracts. It however, does not have the value nor the number of futures instruments in the Chicago

Board of Trade. Two kinds of currency-related products, Won/dollar futures and Won/dollar options, are listed on the KOFEX and they have grown dramatically. The trading volume of USD future contracts now ranks third among listed derivative contracts. However, we do not incorporate USD options contracts into our study due to the fact that were not available at the time of this study.

This paper focuses on the South Korea Stock Price Index 200 (KOSPI 200), won exchange rate and USD future contracts. The daily data used in this paper covered the period from April 23, 1999 to February 28, 2005. The data were time-synchronized and drawn from the Korea Stock Exchange (KSE), the spot currency market and Korea Futures Exchange (KOFEX) respectively.<sup>7</sup> The data thus covered the period of full market liberalization since the government eliminated the foreign investment ceiling completely on May 25, 1998 and the local bond markets and money markets were completely opened up to foreign traders and investors. USD future trading grew due to an increase in institutions' longer-term hedging demand and the high volatility of the underlying exchange rate during the fourth quarter of 2004.

In Korea's financial markets, the three major investor groups with high trading activity in the spot and future foreign exchange rate markets are investment trust companies, banks, and foreigners. Investment trust companies and foreigners have traded actively in the Won/US dollar futures market, while securities firms and other institutional participants have reduced their trading volume.<sup>8</sup>

In order to capture the impact of trading behavior of the three major players for the range volatility of Won/USD rate. Firstly, derived the base line spot trading volume series data and USD futures volume data together with their rates of change.

Then process the first-order differences of the base line data series to generate stationary -  $I(1)$  series. Finally, defined the volatility of the trading volume as a logarithm of the ratio of the daily trading volume:

$$V_{i,t} = \log(v_{i,t} / v_{i,t-1}) \times 100, \quad (1)$$

for  $i = ITCs(I)$   $Banks(B)$   $Foreigners(F)$   $USD Futures(U)$ ,

where  $v_{i,t}$  represents the trading volume of the series  $i$  at day  $t$ , and  $v_{i,t-1}$  represents the trading volume of the series  $i$  at day  $t-1$ , and  $V_{i,t}$  is the rate of change of volume in the data series  $i$ .

<sup>7</sup> The data reported/are from April 23, 1999.

<sup>8</sup> Annual reports by Korea Futures Exchange (KOFEX) showed the trading volume by major investor groups to be investment trust companies, banks, and foreigners excluding individuals.

Range based volatility estimators are highly efficient relative to other returns

based estimators of volatility such as daily squared returns using opening and closing prices. Furthermore, they are robust to noise generated by market frictions: see Brandt and Diebold (2006), Alizadeh, Barandt and Diebold (2002) and Rogers, Christopher and Satchell (1991). Hence, along the lines of Chaboud and LeBaron (2001), this paper measures the volatility of the foreign exchange rate (Won/USD) with a scaled measure of the daily high-low range. This creates the  $X$  variable:

$$X_t = [\log(\text{high}_t) - \log(\text{low}_t)] \times 100, \quad (2)$$

where  $\text{high}_t$  and  $\text{low}_t$  represent the day  $t$  high and low exchange rate of the Won against the USD, respectively.

### 3.2. *Econometric Model*

This study explored if the fluctuation of the foreign exchange rate affects the spot and USD futures trading behavior among the three major investor groups and the relationship between spot and USD future volume. Employed the autoregressive integrated moving average (ARIMA) model to classify the range of the daily high and low of the foreign exchange rate (Won/USD) into expected and unexpected foreign exchange rate range volatilities.

Some scholars have argued that there are asymmetric effects in financial markets due to the expected and unexpected impacts. For example, Bessembinder and Seguin (1993) found that unexpected volume shocks have a larger effect on volatility than expected volume shocks do. The relation is asymmetric and the impact of positive unexpected volume shocks on volatility is larger than the impact of negative shocks.<sup>9</sup>

It was assumed that players use their expectations of the range volatility of the exchange rate to adjust their spot or USD future positions in advance. The two expected and unexpected variables are then added into a multivariate GARCH (1, 1) model. These models are described below.

#### a. *ARIMA model*

The investigation tried to determine whether the major players have asymmetric trading behavior in response to expected and unexpected volatility components. It was defined that the daily range of the high-low exchange rate is the volatility variable within the model. This variable, derived from the ARIMA model, is then divided into two variables, the expected and unexpected components of

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<sup>9</sup> Several related studies, such as Warther (1995), Chen et al. (1999), Chang et al. (2000), Naranjo and Nimalendran (2000), Bekeart and Wu (2000), and Wu (2001) also mention that the expected and unexpected innovation have asymmetric effects.

the daily high-low ranges.<sup>10</sup> It was then observed that the unexpected high-low range component impacts the trading behavior of these major players more than the expected high-low range component does.

In order to use the ARIMA methodology, it is first necessary to identify whether each series is stationary. The ARIMA model can only be used on a stationary series. If it is determined that a series is non-stationary, then it could be differentiated repeatedly until a stationary series occurs. The original  $X$  variable series is transformed into a stationary series by applying the ADF and PP tests, as denoted by  $I(0)$ . Then employ the general ARIMA (p, q) model to derive the expected and unexpected component variables from the high-low range in the  $X$  variable. The ARIMA (p, q) model can be written as follows:

$$X_t = \alpha_0 + \sum_{i=1}^p \alpha_i X_{t-i} + \sum_{i=0}^q \beta_i \varepsilon_{t-i}, \quad (3)$$

where,  $X$  is composed of a logarithm of the daily high-low range of the Won/USD rate, and

$$EX_t = \alpha_0 + E\left(\sum_{i=1}^p \alpha_i X_{t-i}\right) + E\left(\sum_{i=0}^q \beta_i \varepsilon_{t-i}\right), \quad (4)$$

$$UEX_t = X_t - EX_t, \quad (5)$$

where,  $EX_t$  and  $UEX_t$  represent the expected and the unexpected components of the daily high-low range of the Won/USD rate at day  $t$ , respectively.

The optimal ARIMA model is defined. The optimal criteria require that the estimated coefficients be significant, the model generates a minimum AIC value, and the residual terms have no series correlation. It was found that the optimal ARIMA model of the high-low Won/USD rate series is ARIMA (5,0). The expected range of the high and low exchange rate can be evaluated by the actual high-low range subtracted by the optimal residual terms. The residuals are estimated from the ARIMA model. The residual values are interpreted as the unexpected range of the high and low exchange rate.

By creating these two variables, the model may account for whether asymmetric trading behavior does exist. It was demonstrated that the volatility transmission mechanism is asymmetric in effect. Negative innovations (when the high-low range expands) in South Korea's exchange rate market increase the volatility in the spot market and this results in increased trading. Positive innovations (when the high-low range narrows), do not result in increased volatility. Furthermore, trading is not as robust as is the case for negative innovations.

<sup>10</sup> There is another example which employs the general ARIMA (p,0,q) model to divide the expected and unexpected variables from the change in original variables, for example, Lee and Chen (2005).



Braun et al. (1995), Koutmos and Booth (1995) and Geoffrey, Martikainen and Tse (1997), all employed the EGARCH model to investigate that there are volatility asymmetric effects between the futures and spot markets. They assessed whether negative innovations generate a larger impact than positive innovations in these two financial markets. The findings were that most investors will initiate more hedging strategies in the face of negative impacts than in the face of positive impacts.

b. *Multivariate GARCH (1,1) model*

The multivariate GARCH model is not only able to test for the time-varying variance or volatility in the spot and USD futures markets, but it can also be used to investigate volatility transmission among the three markets: exchange rate, spot, and USD futures. This paper adopted a multivariate GARCH (1, 1) model to investigate the dynamic relationships in the three markets to examine the phenomenon of feedback influence arising from USD futures. For the three major players, the USD futures can be traded to hedge their spot position risk or to speculate under the free-floating rate.

After computing the expected and unexpected components of the variables from the ARIMA model in the high-low range series, the conditional mean equation was changed so that both variables are included. With the multivariate GARCH (1,1) model, equations are written as follows:

$$V_{I,t} = \alpha_I + \sum_{i=1}^2 \alpha_{I,1,i} V_{I,t-i} + \sum_{i=0}^2 \alpha_{I,2,i} EX_{t-i} + \sum_{i=0}^2 \alpha_{I,3,i} UEX_{t-i} + \sum_{i=0}^2 \alpha_{I,4,i} R_{t-i} + \varepsilon_{I,t}, \quad (6)$$

$$V_{B,t} = \alpha_B + \sum_{i=1}^2 \alpha_{B,1,i} V_{B,t-i} + \sum_{i=0}^2 \alpha_{B,2,i} EX_{t-i} + \sum_{i=0}^2 \alpha_{B,3,i} UEX_{t-i} + \sum_{i=0}^2 \alpha_{B,4,i} R_{t-i} + \varepsilon_{B,t}, \quad (7)$$

$$V_{F,t} = \alpha_F + \sum_{i=1}^2 \alpha_{F,1,i} V_{F,t-i} + \sum_{i=0}^2 \alpha_{F,2,i} EX_{t-i} + \sum_{i=0}^2 \alpha_{F,3,i} UEX_{t-i} + \sum_{i=0}^2 \alpha_{F,4,i} R_{t-i} + \varepsilon_{F,t}, \quad (8)$$

$$V_{U,t} = \alpha_U + \sum_{i=1}^2 \alpha_{U,1,i} V_{U,t-i} + \sum_{i=0}^2 \alpha_{U,2,i} V_{I,t-i} + \sum_{i=0}^2 \alpha_{U,3,i} V_{B,t-i} + \sum_{i=0}^2 \alpha_{U,4,i} V_{F,t-i} + \varepsilon_{U,t}, \quad (9)$$

$$\varepsilon_{i,t} | I_{t-1} \sim N(0, H_t) \quad H_t = \begin{bmatrix} h_{II,t} & h_{IB,t} & h_{IF,t} & h_{IU,t} \\ h_{IB,t} & h_{BB,t} & h_{BF,t} & h_{BU,t} \\ h_{IF,t} & h_{BF,t} & h_{FF,t} & h_{FU,t} \\ h_{IU,t} & h_{BU,t} & h_{FU,t} & h_{UU,t} \end{bmatrix}. \quad (10)$$

Here  $V_{i,t}$  is the logarithm of the ratio of trading volume in the  $I$ ,  $B$ ,  $F$ , or  $U$  series at day  $t$ . Term  $R_t$  is the logarithm of the ratio of the KOSPI 200 Index at day  $t$ . Terms  $EX_t$  and  $UEx_t$  are respectively the expected and the unexpected components of the daily high-low price of Won/USD at day  $t$ . Term  $R_t$  is the index return of KOSPI 200. Because shocks of the mean equation are the main drivers in the multivariate model, it is important that the mean equation is not misspecified. The var models up to eight lags were estimated and test the individual and joint significance of the coefficients were tested. A lag length of two was chosen by the Akaike information criteria (AIC) (See Table 3).<sup>11</sup> Thus, the time lag length of this model is two days per series.

To model the time-varying covariance matrix  $H_t$ , a multivariate GARCH model.<sup>12</sup> This time-dependent, conditional parameterization is justified by our finding of heteroscedasticity in the volatility of trading volume. For this methodology, Engle and Mezrich (1996) provided a concise survey. This case the four-dimensional time-varying covariance matrix contains four variance series and six covariance series. In the diagonalized parameterization without spillovers the Positive Definite and the Vech models need 30 parameters. Given that we have to include the VAR and the terms for the transmission of volatility shocks, the number of parameters makes the estimation process intractable. On the contrary, the approach proposed by Bollerslev (1990) is less complex, because it restricts the correlation to be constant.<sup>13</sup>

The parameterization for conditional variances is shown in Equation (11) and for covariances in Equation (12):

$$h_{i,t} = c_i + a_i \varepsilon_{i,t-1}^2 + b_i h_{i,t-1} \text{ for } i = I, B, F, U, \quad (11)$$

$$h_{j,t} = \rho_j \sqrt{h_{i,t} h_{j,t}} \text{ for } i \neq j \text{ and } i, j = I, B, F, U. \quad (12)$$

In Equation (11),  $h_{i,t}$  are the variances of  $I$ ,  $B$ ,  $F$ , or  $U$  series. Here, the spillovers of these four volatilities are included as lagged squared innovations. The coefficient  $b_i$  accounts for the identical shock to volatility from the previous day, whereas the coefficients  $a_i$  ( $i = I, B, F, U$ ) measure the impact of the sectoral volatility shocks. To preserve a non-negative variance we estimate the coefficients in the variance equations in absolute value were estimated. In Equation (12), the co-variances  $h_{ij}$  are driven by the variances  $p_{ij}$  and correlation coefficients.

<sup>11</sup> This specification is also employed in Karolyi (1995).

<sup>12</sup> See, for example, Univariate (G)ARCH introduced by Engle (1982) and Bollerslev (1986).

<sup>13</sup> A similar model is employed by Koutmos and Booth (1995).

The log-likelihood function is defined as follows:

$$\Gamma = \sum_{t=1}^T \left( -\frac{n}{2} \ln(2\pi) - 0.5 \mathbf{h}' | H_t |^{-1} \varepsilon_t \right) \quad (13)$$

For the numerical optimization of this function, the investigation started with the simplex algorithm to reduce dependence on the starting values. Then it was switched to the Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm.

#### 4. Empirical Results

Table 1 reports the descriptive statistics of the volatility of each data series.<sup>14</sup> The results obtained with the kurtosis, asymmetry statistics, and the Jarque-Bera normality test showed that their distribution is not like that of a normally distributed series. Ljung-Box tests have been estimated for 35 lags both for these series in level ( $Q(35)$ ) as well as their squares ( $Q^2(35)$ ), and the results revealed autocorrelation problems in all series. The results of the preceding test on the square of the series, together with the significance of the test based on Lagrange multipliers, are a clear indication of the existence of heteroscedasticity problems.

The first stage of the analysis involves determining the stationarity characteristics of these data. For each of the five sample variables, the augmented Dickey and Fuller (ADF) test. The results of the ADF tests are shown in Appendix 1 (Tables A1 and A2) which show that these data contain a unit root and are non-stationary. Further analysis requires a stationary variable; hence, the focus was on analyzing the first difference of the variables.

Karpoff (1987) indicated that a financial market with relative information reflects that information in its trading volume. Trading volume that is accompanied by high activity (volatility), means that the market is transmitting information. This tends to further increase the volatility in the market. In Figure 1 (see Appendix 2) it was observed that large volatilities tend to be followed by large volatilities. The attractiveness and empirical success of GARCH models is that they are able to explain to a large extent the volatility clustering behavior and the excess kurtosis of the empirical distribution of returns.

This table gives descriptive statistics for the change rate of spot and futures volumes on investment trust companies (ITCs, denoted by  $I_t$ ), banks (denoted by  $B_t$ ), and foreigners (denoted by  $F_t$ ), and USD (denoted by  $U_t$ ), respectively.  $R_t$  represents the (return) of KOSPI 200 index. All volatility measures are in daily percentages for the period April 23, 1999 to February 28, 2005.

<sup>14</sup> The data are available from the authors upon request.

**Table 1: Descriptive Statistics**

	$I_t$	$B_t$	$F_t$	$U_t$	$R_t$
Obs.	1438	1438	1438	1438	1438
Mean	-0.0055	-0.0734	0.0572	0.2141	0.0275
Std. Error	32.3387	54.0578	35.8637	45.3302	2.2185
Skewness	0.0428	0.2405	0.0010	0.0760	-0.3324
Kurtosis	1.2142	4.0998	0.8284	1.0513	2.2527
J-B	88.7708 ***	1020.9408 ***	41.1142 ***	67.6111 ***	330.5439 ***
$Q(35)$	279.9861 ***	343.9147 ***	209.9528 ***	240.3849 ***	50.6750 **
$Q^2(35)$	166.6890 ***	407.4168 ***	196.4368 ***	262.4481 ***	221.8526 ***
$LM(10)$	143.9951 ***	224.5361 ***	60.7274 ***	137.6462 ***	58.6613 ***

Notes:  $Q(35)$  and  $Q^2(35)$  are Ljung-Box tests on each series in levels and squared, respectively, for 35 lags which are distributed as  $\chi_{35}^2$  in the null hypothesis of no autocorrelation.  $LM(10)$  is Engle's Lagrange multiplier test (1982) to contrast the existence of ARCH effects, which is distributed as  $\chi_{10}^2$  in the null hypothesis of no autocorrelation. J-B is the Jarque-Bera normality test, which is distributed in the null hypothesis of normality as  $\chi_2^2$ . Significance levels of 10%, 5%, and 1% are represented by \*, \*\*, and \*\*\*, respectively.

After all the data transformations, the multivariate GARCH (1,1) model was used with asymmetric information terms to conduct all the empirical tests.

**Table 2: Results of Conditional Variance Tests**

Conditional Variance Equations: $h_{i,t}$				
	$I$	$B$	$F$	$U$
$C_{Ii}$	418.5873 ***			
$C_{Bi}$	53.6812	172.9110 ***		
$C_{Fi}$	84.5133 **	57.5502	10.2198 ***	
$C_{Ui}$	-26.0719	-455.0855 **	-576.2288 ***	246.2909 ***
$\alpha_{Ii}$	0.0770 ***			
$\alpha_{Bi}$	0.0268 *	0.1003 ***		
$\alpha_{Fi}$	0.0567 ***	0.0467 **	0.0848 ***	
$\alpha_{Ui}$	0.0130 **	0.0273	0.0382 **	0.0611 ***
$\alpha_{Ii}$	0.4121 ***			
$\alpha_{Bi}$	0.8587 ***	0.8234 ***		
$\alpha_{Fi}$	0.7375 ***	0.8222 ***	0.8134 ***	
$\alpha_{Ui}$	0.9494 ***	-0.6625 ***	-0.7836 ***	0.8266 ***
Function Value	-28302.4870			

Note: \*, \*\*, and \*\*\* represent 10%, 5%, and 1% significant level, respectively. The critical value refers to Dickey and Fuller (1981). Optimal lags are chosen by the AIC criteria. The daily data used in this paper cover the period from April 23, 1999 to February 28, 2005.

Table 2 presents the estimates for the conditional mean equations of the trading volume volatilities. It shows that the spot trading volatility of the three major trading groups in South Korea and the trading volatility of USD futures are strongly influenced by their own past innovations.

The parameters  $\alpha_{j,1}$  are all negative and significant, which suggests that trading volume is larger (smaller) on this day is followed by trading volume that is smaller (larger) in volatility on the next day.

$\alpha_{j,1}$  and  $\alpha_{j,2}$  are all also significantly negative. Together, this implies that these three groups of participants will try to revise their trading positions when the spot trading volatility (in the foreign exchange markets) was unforeseen on the preceding day. On the other hand, they will enter the stock market when the spot trading volatility was stable on the preceding day. It was found that the effect of trading volatility on the spot and USD future volume, has a progressively declining impact (on own trading volume) over time.

Considering the expected and unexpected terms of conditional mean equations (6)~(8) in Table 2,  $\alpha_{j,2}$  and  $\alpha_{j,3}$  are represented by the expected and unexpected range components of the daily high and low Won/dollar rates, respectively. An insignificant  $\alpha_{j,2}$  and a significant positive  $\alpha_{j,3}$  together demonstrated that only the daily unexpected range of the high-low Won/USD rates impacts the trading activities of these three major groups. They will modify their long or short spot positions only according to the daily unexpected exchange rate range. When the daily unexpected range expands (narrows), their trading volume and volatility would increase (decrease) on such a day.<sup>15</sup> It is worth noting that the expected range of the exchange rate has no effect on the trading behavior of any member of the trading classes that were analyze. However, it was conclusively shown that they display asymmetric trading behavior in the spot market after the markets have been liberalized.

Several coefficients  $\alpha_{j,4}$  are significantly positive, suggesting that these three major players will hold long or short spot positions when the returns on the KOSPI 200 index increase (decrease). Among the major market participants, trading by the banks has the most impact on the variation of the KOSPI 200 index return. Relative to the banks, the ITCs have a smaller but still substantial impact on the index return. It may therefore be reasonably concluded that the KOSPI 200 index return does not apparently impact nor is it impacted by the trading behavior of foreigners. The index return has the most effect on the banks because the coefficient  $\alpha_{B,4,1}$  has the largest estimation value in all  $\alpha_{j,4,1}$ . The index return also has a more prolonged effect upon the ITCs as the  $\alpha_{I,4,1}$  and

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<sup>15</sup> It is useful to note that negative innovations coincide with an expansion of the range, so that when the range expands traders are reacting to the arrival of adverse news and hence volatility and trading volumes increase.

$\alpha_{I,4,2}$  are all positively significant. The evidence that the trading behavior of foreigners is not significantly affected by the daily movement of the KOSPI 200 index thus seems to lend weight to the fact that foreign investors are long term investors. It would be expected the trading activities of long-term investors not to be sensitive to daily variation in the index. Another explanation could be that of the higher trading costs that they face as suggested by Choe, Kho and Stulz (2005).

The estimated results of Equation (9) uncover whether these three major categories of investors will hold long or short spot positions by trading USD futures for hedging and speculation purposes under the free-floating system. According to the results of Equation (9), the coefficients  $\alpha_{j,2}$  are all positive and significant. This indicates that only ITCs will buy or sell stocks while trading USD futures. It is presumed that the ITCs will rearrange their spot positions against the unexpected range volatility of the exchange rate and then hold long or short USD futures as needed at the same time. This is in order to avoid any loss under the exchange rate fluctuation. The banks and foreigners, however, have no obvious trading behavior like the ITCs, relatively speaking.

This table reports the maximum-likelihood estimation results of equations (11) to (12), which  $c$  is the constant in the variance and covariance equations,  $a$  is the coefficient for the lagged squared residuals, and  $b$  is the conditional variance and covariance coefficient.

Table 2 shows the results of the conditional variance equations. The coefficients  $b$  are all significant, implying that there are volatility-clustering phenomena among the trading volatilities of these three major groups and USD futures. In addition, it is more like the contemporaneous correlation of volatilities across trader types.

The LR1, LR2, and LR3 of Table 2 test whether unexpected innovations (the case where the unexpected high-low range of Won/USD expands) cause a larger current volatility than expected innovations. The results for ITCs and banks are positive and the result of foreigners is negative. However, only LR1, the case for investment trusts, is significantly positive and it fits the assumption of the information asymmetric theory on financial securities (such as Braun et al. (1995)). If a market participant ignores the asymmetric characteristics of unexpected innovations, in anticipating the volatility of the exchange rate market, then exchange rate exposure will increase and profits may be impaired.

It may be concluded from this evidence that the ITCs should hold long or short spot positions in USD futures for purposes of hedging their asset positions under the free-floating exchange rate system. The banks and foreigners, however, would reduce investment in the stock market under an uncertain and volatile exchange rate. So in summary, if market liberalization results in more stable exchange rates this would be beneficial if the country wanted to attract foreign capital inflows.

**Table 3:** Asymmetric Information Effect Tests

Likelihood Ratio	Hypothesis Test	Estimated Value	Statistics
LR1	$H_0 : \hat{\alpha}_{I,3,1} + \hat{\alpha}_{I,3,2} = \hat{\alpha}_{I,2,1} + \hat{\alpha}_{I,2,2}$	13.5526	2.8998*
LR2	$H_0 : \hat{\alpha}_{B,3,1} + \hat{\alpha}_{B,3,2} = \hat{\alpha}_{B,2,1} + \hat{\alpha}_{B,2,2}$	58.4442	0.0571
LR3	$H_0 : \hat{\alpha}_{F,3,1} + \hat{\alpha}_{F,3,2} = \hat{\alpha}_{F,2,1} + \hat{\alpha}_{F,2,2}$	-24.1629	1.4625

Note: LR is the likelihood ratio test. 2. LR1~LR3 are all  $\chi^2(1)$  distributions. Significance levels of 10%, 5%, and 1% are represented by \*, \*\*, and \*\*\*, respectively

## 5. Conclusion

This paper investigated the trading behavior of investment trusts, banks and foreigners under the free-floating exchange rate system in South Korea's financial markets. Unlike previous studies, this paper incorporates the trading activities of the participants in the spot currency market, stock market and Won/USD future market. An ARIMA model was first employed to divide the daily range of high and low Won/USD prices into two types, the daily expected and unexpected ranges. These two variables were incorporated into a multivariate GARCH model to analyze whether the range volatility of the exchange rate would impact the participants' spot trading activities. If they did, then they trade USD futures for hedging or speculation accordingly.

The overall results indicated that, to some extent, only daily unexpected volatility in Won/USD impacts the trading behavior of these three major market participants. They would modify their long or short spot positions only when daily unexpected range innovations occur. That is, when the daily unexpected range expands (narrows), their trading volume and volatility would increase (decrease) on that day. This is quite the type of rational behavior that one would have predicted. Traders in the markets only react to unexpected information. Expected innovations are already incorporated into their trading plans and hence trigger no revisions in their plans.

Thus it was shown that the three players have asymmetric and rational trading behavior on the spot market under the free-floating system in South Korea. Negative innovations lead to higher volume of trading and higher volatility in all the markets. The traders do not respond to expected volatility, only to *unexpected* volatility. Furthermore, only ITCs would trade spot and USD futures simultaneously. It is presumed that the ITCs re-arrange their spot positions according to the unexpected range volatility of the exchange rate expected as it occurs, and then go long or short USD futures as needed.

There is some evidence suggesting that the trading behavior of foreigners in the stock market is not significantly impacted by movements of the index nor does their trading affect the market index returns. This evidence is consistent with two channels of reasoning. Either foreigners in Korea are long-term value investors who by definition will not be sensitive to short-term (daily) movements in the index or they are subject to higher trading costs than are domestic participants. It is hoped that the availability of better data will help sort out which of these explanations is appropriate for the market. However, there was no evidence of irrationality found on the part of the participants or that there is any element of instability in the markets that were analyzed.

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**Appendix 1:** Table A1. Augmented Dickey Fuller (ADF) Tests for Spot Trading Volume of ITCs, Banks, and Foreigners and Futures Volume of USD

Variables	Without Drift and Trend		With Drift and Trend		Constant only	
	Lag(s)	Statistics	Lag(s)	Statistics	Lag(s)	Statistics
<b>Log Levels</b>						
Spot volume of ITCs	18	-0.9421	18	-4.3771 ***	18	-4.0601 ***
Spot volume of banks	15	-4.4038 ***	15	-7.3298 ***	15	-7.0726
Spot volume of foreigners	19	-0.4401	20	-5.1326 ***	20	-2.9916 **
USD futures volume	19	-0.4184 ***	18	-4.3506 ***	18	-3.3156 **
<b>First Differences</b>						
Spot volume of ITCs	17	-14.2327 ***	17	-14.2239 ***	17	-14.2275 ***
Spot volume of banks	20	-12.1301 ***	20	-12.1193 ***	20	-12.1253 ***
Spot volume of foreigners	18	-13.5656 ***	18	-13.5681 ***	18	-13.5718 ***
USD futures volume	18	-14.8211 ***	18	-14.9810 ***	18	-14.8879 ***

Note: \*, \*\*, and \*\*\* represent 10%, 5%, and 1% significant level, respectively. The critical value refers to Dickey and Fuller (1981). Optimal lags are chosen by the AIC criteria. The daily data used in this paper cover the period from April 23, 1999 to February 28, 2005.

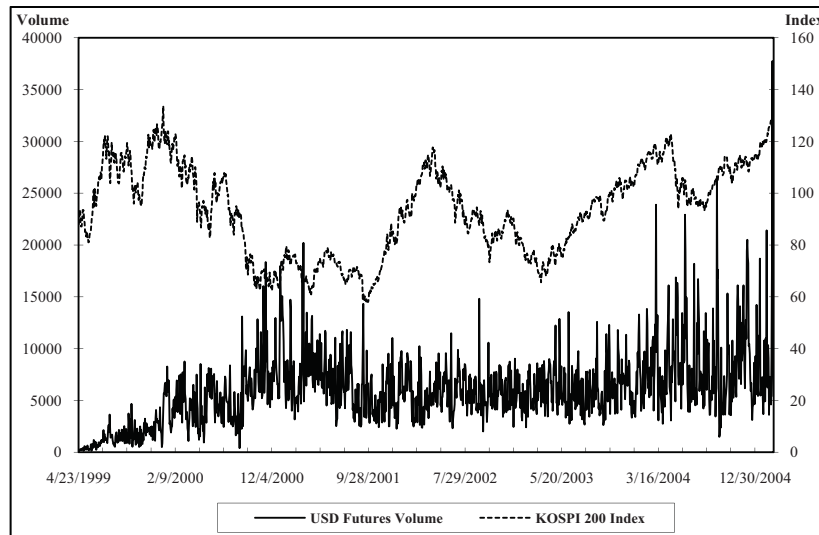
Table A2, Akaike and Schwarz Information Criteria

Appropriate model selection criteria are the Akaike information criterion (AIC) and the Schwarz information criterion (SIC). We choose the value of  $p$  that minimizes the AIC and SIC. The AIC selects  $p = 2$ , whereas SIC selects  $p = 3$ . It is well known that the SIC penalizes additional parameters more heavily than the AIC, as the SIC prefers a more parsimonious model. Based on the selection criteria and the results of the statistical tests, we choose the var(2) specification.

$P$	AIC	SIC
1	27.71567	27.92105
2	26.09832 *	27.68363
3	26.10565	27.67109 *
4	26.22056	27.76634
5	26.94054	27.86686
6	26.88849	27.99555
7	26.87544	28.16345
8	26.84778	28.31694

Note:  $p$  denotes the lag in VAR( $p$ ). \* denotes the minimum value of the information criteria.

**Appendix 2:** Figure 1. The Trend of Daily USD Futures Volume and KOSPI 200 Index



**Table 4.** Results Estimation of the Multivariate GARCH (1,1) Model

	Conditional Mean Equations: $V_{i,t}$											
	$\alpha_j$	$\alpha_{j,1,1}$	$\alpha_{j,1,2}$	$\alpha_{j,2,1}$	$\alpha_{j,2,2}$	$\alpha_{j,2,3}$	$\alpha_{j,3,1}$	$\alpha_{j,3,2}$	$\alpha_{j,3,3}$	$\alpha_{j,4,1}$	$\alpha_{j,4,2}$	$\alpha_{j,4,3}$
<b>Panel A: For Equation (6)</b>												
$V_i$	4.0855**	-0.4844***	-0.2263***	-13.4731	25.9343	-20.2388	22.9869***	3.0268	-13.0753*	1.9580***	1.1378***	-0.3777
<b>Panel B: For Equation (7)</b>												
$V_B$	5.6524	-0.5299***	-0.2496***	-31.1628	-4.7246	26.2136	15.9959***	6.5609	-2.8712	2.8157***	0.6796	-0.7690
<b>Panel C: For Equation (8)</b>												
$V_F$	1.7620	-0.3603***	-0.2942***	15.6868	21.5270	-39.9313	16.1421***	-3.0912	-11.3698	0.6283	0.6520	-0.2062
<b>Panel D: For Equation (9)</b>												
$V_U$	-0.0393	-0.4562***	-0.2285***	0.8715***	0.4638***	0.1929***	-0.0725	-0.0433	-0.0057	0.0978	0.0067	0.0585

Note: Significance levels of 10%, 5%, and 1% are represented by \*, \*\*, and \*\*\*, respectively.

This table reports the maximum-likelihood estimation results of equations (6) to (9). The sample data span the period April 23, 1999 to February 28, 2005. **They contain 1,439 observations.** Daily continuous change rates are constructed using the formula  $V_{i,t} = \log(v_{i,t}/v_{i,t-1}) \times 100$ , where  $v_t$  is the volume of each investor group at time  $t$ ,  $\alpha_j$  is the constant in the mean equation, and  $\alpha_{j,1}$  is the own lagged variables for each series. In equations (6) to (8),  $\alpha_{j,2}$  and  $\alpha_{j,3}$  are the coefficients for the expected and unexpected Won/USD ranges, respectively, and  $\alpha_{j,4}$  is the return of KOSPI 200 coefficient. In equation (9),  $\alpha_{j,2}$ ,  $\alpha_{j,3}$ , and  $\alpha_{j,4}$  are the spot trading behaviors for the three investor groups, respectively.